Introduction

Chapter Overview

Most Americans have highly positive attitudes toward science and technology. There is strong support for government investment in basic research, and Americans also appreciate technological advancements, especially rapidly expanding communication capabilities such as the Internet, which have permeated—and are having a pervasive impact on—an ever expanding number of daily living activities.

The news about science literacy is less positive. Americans do not seem to know much about science, especially the scientific process. Moreover, the prevalence of scientific illiteracy, or a dearth of critical thinking skills, may mean that many Americans are not adept at making, or adequately prepared to make, well-informed choices at the ballot box or in their personal lives.

Most Americans rely on television and newspapers as their major sources of information. Although the media can be commended for providing more access to more information than ever before, there is some concern that the press—with more cooperation from the science and engineering community—could do a better job of informing the public about science and technology and their contribution to economic prosperity, national security, and the health and well-being of society. In addition, the increase in information has led to "information pollution" or the presentation of fiction as fact in a growing number of television shows. The fact that many Americans are having trouble distinguishing between the two has caught the attention of the science—and science policy—community, where concern about the state of scientific literacy has never been higher. A technological society, one that is increasingly dependent on the intellectual capacity of its citizens, cannot afford to ignore ignorance.

Chapter Organization

This chapter begins with a discussion of the public's interest in, and knowledge about, science and technology. The level of interest in science and technology is an indicator of both the visibility of the science and engineering community's work and the relative importance accorded science and technology by society. The first section also contains data on the level of public understanding of basic science concepts and the nature of scientific inquiry and information on the level of interest and understanding in other countries.

In the second section, public attitudes toward science and technology are examined. Data on public attitudes toward Federal funding of scientific research and public confidence in the science community are included. In addition, this section contains information on public perceptions of the benefits and harms (or costs) of scientific research, nuclear power, genetic engineering, space exploration, and the use of animals in scientific research.

The third section is devoted to a discussion of computer usage, which is a relatively new way for the public to have access to information about science and technology. The fourth section covers findings from a recent study on science and the media. Finally, concerns about belief in paranormal phenomena are examined in the last section of this chapter.

Interest in—and Knowledge about—Science and Technology

Americans are quick to say they are interested in news about science and technology. In NSF surveys[1] conducted during the past two decades, about 9 of every 10 adults report being very or moderately interested in new scientific discoveries and the use of new inventions and technologies. However, the number who feel well—or moderately well—informed about these subjects is considerably smaller, and evidence shows their lack of confidence in their knowledge is justified. That is, most Americans know a little, but not a lot, about science and technology.[2]

In this section, four topics will be covered:

- ♦ public interest in science and technology and other issues,
- ♦ the public's self-assessed level of knowledge about science and technology and other issues,

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[1]Thirteen of the 14 *Indicators* volumes published since 1972 have included a chapter on public attitudes toward and understanding of science and technology. The surveys for the 1972, 1974, and 1976 *Indicators* contained a block of 20 items inserted into an omnibus national personal interview survey conducted by Opinion Research Corporation of Princeton, New Jersey. The 1979 survey was designed by Miller and Prewitt (1979) and analyzed by Miller, Prewitt, and Pearson (1980); the personal interviews were conducted by the Institute for Survey Research at Temple University. Additional national surveys were undertaken for the 1982, 1985, 1987, 1991, and 1993 *Indicators* reports, with telephone interviews conducted by the Public Opinion Laboratory of Northern Illinois University. The chapter for *Science Indicators – 1985* was based on a national telephone survey conducted by the Public Opinion Laboratory for Professor George Gerbner of the Annenberg School of Communication at the University of Pennsylvania. In 1995, 1997, and 1999, the Chicago Academy of Sciences conducted surveys that continued the core of attitude and knowledge items from previous *Indicators* studies and included telephone interviews with a random-digit sample of 2,006 adults in 1995, 2,000 in 1997, and 1,882 in 1999. The interviews for the 1995 survey were conducted by the Public Affairs Division of Market Facts Incorporated. The interviews for the 1997 and 1999 surveys were conducted by the National Opinion Research Center. The results can be found in past volumes of *Indicators* (NSB biennial series).

In general, the response rate for each of the NSF surveys has been at 70 percent or higher. However, for the 1999 survey, the response rate was 66 percent. For more information on the 1999 survey methodology, see Miller, Kimmel, and Hess 2000.

[2]It is often suggested that people tend to respond to surveys by supplying what they think are "correct" or "expected" answers. For example, expressing interest in news stories about science and technology could be deemed a correct response. Although surveys (in addition to NSF's) have consistently shown high levels of interest in science and technology (Gannett 1996, Pew Research Center 1997), evidence that the average news consumer actually pays attention to reports covering these topics is lacking (Hartz and Chappell 1997). Research sponsored by the Pew Center for the People and the Press provides further insight leading to the conclusion that people may not be entirely truthful when responding to survey questions about their interests in various types of news subject. The study revealed that, although relatively few people claim to have interest in news stories about celebrities and scandal, their actual level of knowledge about these subjects is higher than that for any other news category (Parker and Deane 1997).

- the "attentive" public for science and technology policy, and
- public understanding of science and technology.

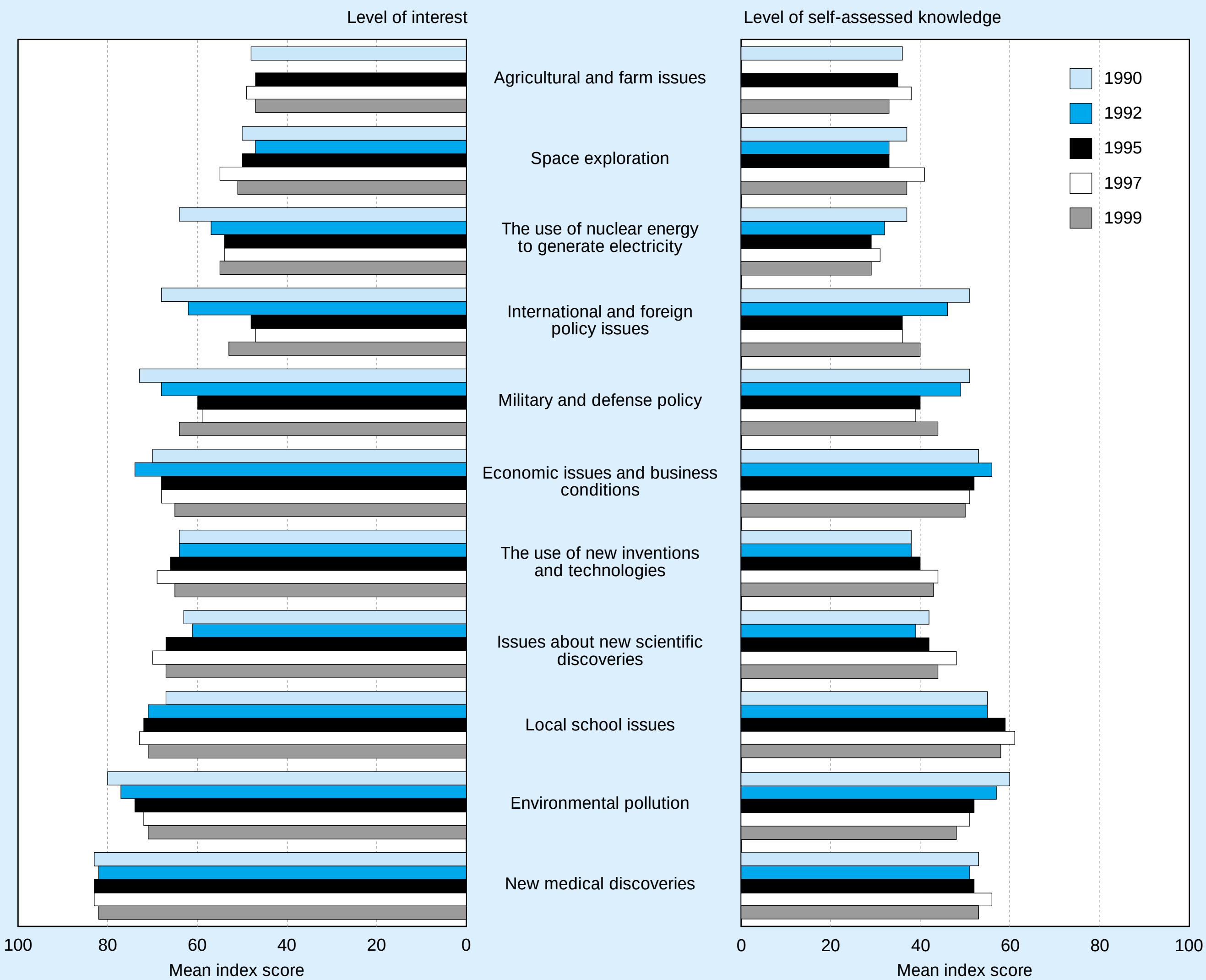
Public Interest in Science and Technology and Other Issues

U.S. residents say they are quite interested in science and technology. More than 40 percent of those who participated in NSF's 1999 Survey of Public Attitudes Toward and Understanding of Science and Technology said they were very interested in new scientific discoveries and in the use of new inventions and technologies; another 40 to 50 percent said they were moderately interested in these subjects; and about 10 percent reported no interest. (See appendix table 8-1.) Among the 11 topics included in the survey, only the level of interest in new medical discoveries, environmental pollution, and local school issues appears higher. (See figure 8-1.)

Approximately two-thirds of the respondents said they were very interested in new medical discoveries. None of the other policy issues received anywhere near such a high percentage of "very interested" responses.[3] Local school issues was a

[3]Surveys sponsored by Research!America show overwhelming public support for medical research. It is not a coincidence that the high level of support—coupled with the high level of interest in new medical discoveries—coincides with historically strong Federal financial support of research sponsored by the National Institutes of Health (NIH) (Hartz and Chappell 1997). (See chapter 2, " U.S. and International Research and Development: Funds and Alliances.") Interestingly, NIH has relatively little name recognition; less than 5 percent of the public can name the government agency that funds most of the medical research paid for by taxpayers. In contrast, 57 percent can name the National Aeronautics and Space Administration (NASA), and 70 percent can name the Food and Drug Administration (Research!America 1999).

Figure 8-1.
Indices of public interest in and self-assessed knowledge about scientific and technological issues: 1990–99



See appendix tables 8-2 and 8-5.

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distant second, with 54 percent of the respondents saying they were very interested in this topic, followed by environmental pollution at 51 percent. (See appendix table 8-1.)

Issues receiving between 40 and 50 percent "very interested" responses were new scientific discoveries (45 percent), military and defense policy (42 percent), economic issues and business conditions (42 percent), and the use of new inventions and technologies (41 percent). Percentages for the other four issues ranged from 30 percent for international and foreign policy to 22 percent for agricultural and farm issues. Interest in space exploration is relatively low; it ranked next to last among the 11 issues.[4] (See appendix table 8-1.)

Interest in science and technology may be at its highest level ever. Using a 0–100 index,[5] the average level of public interest in new scientific discoveries ranged between 67 and 70 in the late 1990s; only in one other year (1983) did it reach that level, although it has always been at 60 or higher. Interest in new inventions and technologies tracks quite closely with that of new scientific discoveries; in 1999, the index levels for the two issues were 65 and 67, respectively. (See figure 8-2 and appendix table 8-2.)

New medical discoveries is the only issue that has consistently had index scores in the 80s; those for environmental pollution and local school issues have generally been in the 70s. Interest in environmental pollution seems to have subsided slightly in the 1990s. (See appendix table 8-2.)

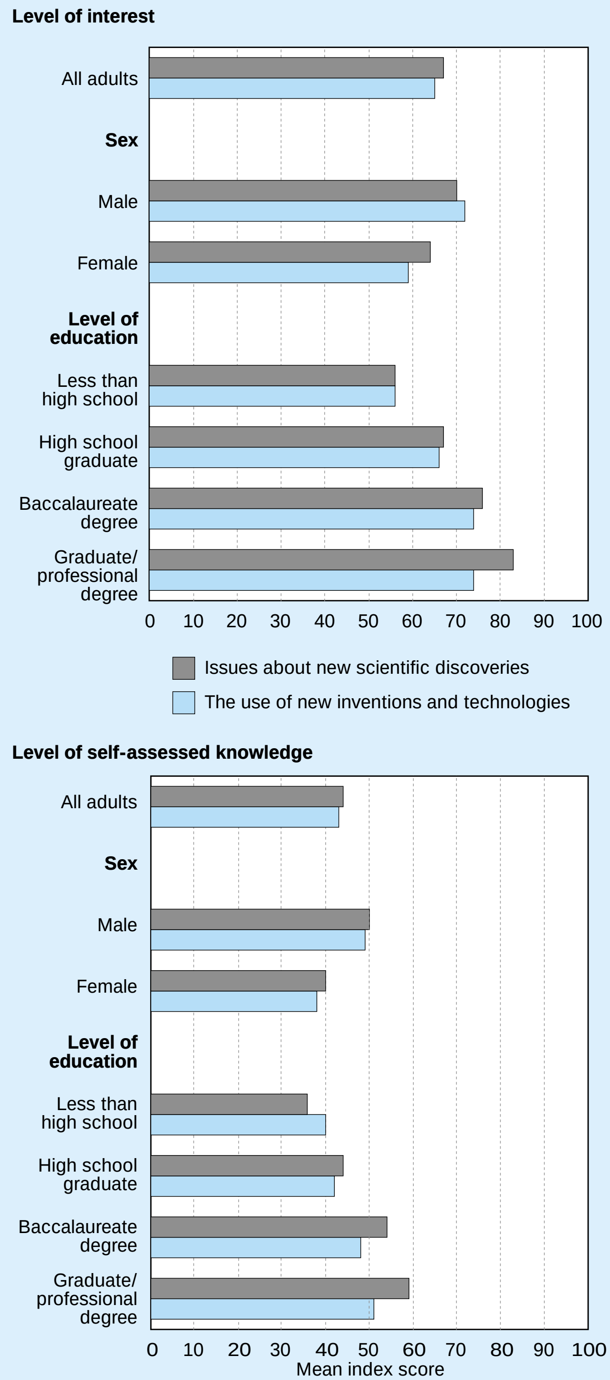
Among the other survey findings:

- Interest in economic issues and business conditions has dipped somewhat since 1992, when it ranked third among the 11 issues in the survey. The decline in interest may be attributable to the health of the U.S. economy in the mid- and late 1990s.

- Interest in military and defense policy and in international and foreign policy reached a peak in 1990 (coinciding with the pending Gulf War at the time the survey was conducted). Interest in international and foreign policy took an upward swing between 1997 and 1999, from 47 to 53, which may reflect heightened interest stemming from the war in the Balkans.

- Interest in the use of nuclear energy to generate electricity fell from 64 in 1990 to 54 in 1995; little change in the level of interest occurred in the late 1990s. (See appendix table 8-2.)

Figure 8-2.
Indices of public interest in and self-assessed knowledge about scientific and technological issues, by sex and level of education: 1999



See appendix tables 8-3 and 8-6.

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Comparing Interest by Sex and Level of Education

Men express more interest than women in new scientific discoveries and in the use of new inventions and technologies. (See figure 8-2.) The gap is particularly large for the latter. Only space exploration has a larger disparity. Men also

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[4]An earlier survey produced results mirroring those of NSF's: 43 percent of that survey's respondents said they were very interested in learning more about science discoveries in general, and 45 percent said they were very interested in learning more about new inventions. In addition, 67 percent reported being very interested in learning more about advances in medicine. In contrast, only 32 percent had this level of interest in learning more about space exploration (Roper 1996).

[5]Responses were converted to a 0–100 scale by assigning a value of 100 for a "very interested" response, a value of 50 for a "moderately interested" response, and a value of 0 for a "not at all interested" response. Indices were obtained by adding all the values for each issue and taking the average.

express more interest than women in economic and business conditions, military and defense policy, international and foreign policy, and nuclear energy. Women are more interested in new medical discoveries, environmental pollution, and local school issues. (See appendix table 8-3.)

Level of formal education and number of mathematics and science courses taken are strongly associated with interest in new scientific discoveries. (See figure 8-2 and appendix table 8-3.) The relationship between education and level of interest is also strong for space exploration, economic issues and business conditions, and for international and foreign policy—and somewhat less strong for the use of new inventions and technologies and new medical discoveries. Local school issues, the use of nuclear energy to generate electricity, and environmental pollution do not seem to show a relationship between level of interest and level of education. Finally, those with relatively low levels of formal education are more likely than others to express high interest in agricultural and farm issues. (See appendix table 8-3.)

International Comparisons

In general, a substantial amount of similarity exists between U.S. residents and those in three other “sociopolitical systems,”[6] in terms of interest in particular public policy issues.[7] For example, for all four—the United States, the European Union, Japan, and Canada—the Index of Issue Interest in environmental issues is in the low to middle 70s. However, survey respondents in the United States and Canada seem to have higher levels of interest in health and medical issues than their counterparts in Europe and Japan. (See text table 8-1.)

Americans are somewhat more interested than Europeans in new scientific discoveries and in new inventions and technologies, whereas Europeans are slightly more interested than Americans in environmental issues.

The Japanese appear to be less interested than Europeans or North Americans in science and technology. In general, Japanese adults express relatively more interest in economic matters and local issues—for example, land use—than in new scientific discoveries and the use of new inventions and technologies. A significantly higher percentage of college-educated respondents in Japan (compared with the percentage of those with less formal education) reported substantial interest in scientific and technological issues, which is also the case in Europe and in North America (Miller, Pardo, and Niwa 1997).

[6]The term “sociopolitical systems” is used because data for Europe were collected with one survey, the 1992 Eurobarometer. Residents of 11 countries participated in this survey. Those countries are Belgium, Denmark, England, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.

[7]The international information in this chapter comes from a comparative analysis of data from the following sources: the 1992 Eurobarometer, the 1995 NSF Survey of Public Understanding of and Attitudes Toward Science and Technology, the 1991 Japan National Study, and the 1989 Canadian National Study (Miller, Pardo, and Niwa 1997).

Text table 8-1.
Issue interest index scores for the European Union, the United States, Japan, and Canada

Issue	Mean scores: European Union (1992)	United States (1995)	Japan (1991)	Canada (1989)
New scientific discoveries	61	67	50	63
New inventions and technologies	59	66	53	58
New medical discoveries	68	83	65	77
Environmental issues	75	74	71	74
Space exploration	–	50	45	48
Energy/nuclear power	–	54	59	–
Computers and related technologies	–	–	–	43
Economic policy	–	68	65	52
Education/local schools	–	72	62	–
Agricultural issues	–	47	56	–
Military/defense issues	–	60	56	–
Foreign & international policy	–	48	55	–
Politics	55	–	–	50
Sports news	48	–	–	42
Taxes	–	–	71	–
Land use issues	–	–	65	–
Senior citizen issues	–	–	74	–

– = Issue not included in the survey

SOURCE: J.D. Miller, R. Pardo, and F. Niwa, *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Chicago: Chicago Academy of Sciences,1997).

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The Public's Self-Assessed Level of Knowledge about Science and Technology and Other Issues

In general, Americans do not believe they are well informed about issues pertaining to science and technology. In fact, for all issues included in the NSF survey, the level of self-assessed knowledge appears considerably lower than the level of expressed interest. This is especially true for complex subjects, like science and technology, where a lack of confidence in understanding what goes on in laboratories or within the policymaking process is understandable. For example, in 1999, at least 40 percent of respondents in NSF's public attitudes survey said they were very interested in science and technology. Yet only 17 percent described themselves as well informed about new scientific discoveries and the use of new inventions and technologies; approximately 30 percent thought they were poorly informed. (See appendix table 8-4.)

Thus, index scores for the responses to the questions having to do with how well informed people think they are about various issues were lower than those for the level of interest in those same issues. (See figure 8-1.) In 1999, three had index scores in the 50s (local school issues, new medical discoveries, and economic issues and business conditions); five, in the 40s (environmental pollution, new scientific discoveries, military and defense policy, the use of new inventions and technologies, and international and foreign policy); and three, in the 20s or 30s (space exploration, agricultural and farm issues, and the use of nuclear energy to generate electricity). (See appendix table 8-5.)

In the 1990s, for most issues, there were no discernible trends in the level of self-assessed knowledge. However, there seems to have been a decline in perceived knowledge about environmental pollution and the use of nuclear energy to generate electricity. (See appendix table 8-5.)

Level of Self-Assessed Knowledge, by Sex and Level of Education

For 8 of the 11 issues in the 1999 survey, male respondents reported higher self-assessment of their knowledge than female respondents. For five of these issues—economic issues and business conditions, military and defense policy, the use of new inventions and technologies, international and foreign policy, and space exploration—the gender gap is more than 10 index points. (See appendix table 8-6.)

In contrast, women have higher index scores than men on two issues—local school issues and new medical discoveries—but the disparity in scores between the two sexes is relatively small. For environmental pollution, the index scores were identical in 1999.

As expected, generally, the more education one has—and the more mathematics and science courses one has taken—the better informed one thinks he or she is. The relationship between education and self-assessed knowledge is particularly strong for new scientific discoveries, the use of new inventions and technologies, and space exploration. It is also strong for economic issues and business conditions and for international and foreign policy issues, but weak or nonexistent for the other issues in the survey. (See appendix table 8-6.)

The "Attentive" Public for Science and Technology Policy

No one has the time or the inclination to keep up with every issue on the public policy agenda. Moreover, not many people are interested in many issues. A recent study contained the following conclusion:

> An analysis of public attentiveness to more than 500 news stories over the last 10 years confirm[ed] that the American public pays relatively little attention to many of the serious news stories of the day. The major exceptions to this rule are stories dealing with natural and man-made disasters and U.S. military actions[8] (Parker and Deane 1997).

Also, different people will be interested in, and will be well informed about, different issues. Some are interested in particular issues that affect their daily lives. For example, parents of school-age children are more likely than others to show interest in issues having to do with the quality of schools in their communities. Chances are these parents are not only interested in, but well-informed about, local school issues. Others are just interested in particular issues, and because of their interest, they have taken the time to become knowledgeable about them; they probably also follow public policy developments in their areas of interest.

It may not be easy to pinpoint exactly who is the audience for issues pertaining to science and technology policy. It is probably safe to say that members of the science and engineering workforce, especially those in the academic community, are probably interested in, and well informed about, various science and technology policy issues, but the number of members in this community is relatively small. (See chapter 3, "Science & Engineering Workforce," and chapter 6, "Academic Research and Development: Financial and Personnel Resources, Support for Graduate Education, and Outputs.") In addition, other members of the public follow news reports about new scientific discoveries and new inventions and technologies. It is interesting to single out the audience for science and technology policy so that their attitudes and knowledge can be compared with those of everyone else.

Therefore, it is useful to classify the public into three groups:

- The attentive public: Those who (1) express a high level of interest in a particular issue, (2) feel well-informed about that issue, and (3) read a newspaper on a daily basis, read

[8]The most closely followed news stories from 1986 through the middle of 1999 were identified by the Pew Research Center for People and the Press. In all, there were 689 such stories. Only 39 can be considered to have anything to do with science or technology, a small proportion (less than 6 percent) of the total. Most of those have to do with weather and earthquake coverage, lending credence to the truism that stories about natural and made disasters are more likely than others to grab the public's attention. It should be noted that a science-related story is at the top of the list: the most closely watched story of the period was the explosion of the Space Shuttle Challenger in 1986. (See sidebar, "The Most Closely Followed Science-Related News Stories: 1986–99.")

The Most Closely Followed Science-Related News Stories: 1986–99

For nearly 15 years, the Pew Research Center for the People and the Press (1999b) has been tracking the most closely followed news stories in the United States. Out of 689 stories identified by the Center during the period, 39 have at least some relevance to science and medicine. Those stories, and the month and year the public was surveyed (which is a good indication of when the event occurred), are listed below. Next to each entry is the percentage of those surveyed who said they were following the story "very closely" (the other choices given to respondents were "fairly closely," "not too closely," or "not at all closely").

Weather is the subject of 12 of the stories on the list; they are clustered toward the top. Ten stories involve coverage of space exploration, including the lead story of the period studied, the explosion of the Space Shuttle Challenger. Four news stories are about earthquakes and the damage they cause. Two are about problems at nuclear reactor plants. Health is the subject of six stories, and three are about efforts to clone animals and people.

80%	Explosion of the Space Shuttle Challenger (July 1986)
73%	Destruction caused by the San Francisco earthquake (November 1989)
66%	Hurricane Andrew (September 1992)
65%	The floods in the Midwest (August 1993)
63%	Earthquake in Southern California (January 1994)
51%	News about cold weather in the Northeast and Midwest (January 1994)
50%	Flight of the Space Shuttle (October 1988)
49%	Drought and its effects on American farmers (August 1988)
48%	The blizzard on the East Coast (January 1996)
46%	Nuclear accident at Chernobyl in the Soviet Union (July 1986)
42%	Hot weather this summer and the greenhouse effect (August 1988)
39%	Unseasonable weather patterns (December 1998)
38%	The heat wave and its impact throughout the country (July 1998)
37%	The floods in California (March 1995)
36%	Hurricane Mitch and the rain and mudslides in Central America (November 1998)
34%	John Glenn's flight on the Space Shuttle Discovery (November 1998)
34%	Floods in the Pacific Northwest (January 1997)
34%	Reports about flooding in Texas and other southwestern states (June 1990)
28%	Problems at nuclear reactor plants (October 1988)
25%	The earthquake in Japan (February 1995)
24%	The breast implant controversy (February 1992)
24%	Deployment of the Hubble Space Telescope (May 1990)
23%	The controversy over whether women in their forties should have regular mammograms (February 1997)
22%	The exploration of the Planet Mars by the Pathfinder Spacecraft (August 1997)
22%	Discoveries made by the spacecraft Voyager 2 (September 1989)
21%	Plans by a Chicago scientist to open a clinic for cloning people (January 1998)
20%	Earthquake in Iran (July 1990)
19%	The outbreak of an Asian flu spread by birds or chickens (January 1998)
17%	The cloning of a sheep by a Scottish biologist (April 1997)
15%	The new drug Viagra designed to help men overcome impotence (June 1998)
15%	The problems aboard the Russian Space Station Mir (September 1997)
14%	The problems aboard the Russian Space Station Mir (August 1997)
11%	The return of Space Shuttle astronaut Shannon Lucid to Earth (October 1996)
11%	The outbreak of plague in India (October 1994)
9%	The debate over U.S. policy concerning global warming (November 1997)
9%	Discovery of scientific evidence of the beginnings of the universe (May 1992)
9%	AIDS conference in San Francisco (July 1990)
8%	NASA's discovery of possible life on Mars (September 1996)
6%	The cloning of mice by scientists in Hawaii (July 1998)

a weekly or monthly news magazine, or read a magazine relevant to the issue.[9]

- The interested public: Those who claim to have a high level of interest in a particular issue, but do not feel well informed about it.
- The residual public: Those who are neither interested in, nor feel well-informed about, a particular issue.

There is an attentive public for every policy issue; these groups differ in size and composition.

Data for 1999 show that, for most issues covered by the NSF survey, less than 10 percent of the public can be considered attentive. New medical discoveries has the largest audience: 16 percent of all survey respondents in 1999 were classified as attentive to that subject. (See appendix table 8-7.)

Those likely to be attentive to science and technology policy issues are identified by combining the attentive public for new scientific discoveries with the attentive public for new inventions and technologies. In 1999, 12 percent of the population qualified for that distinction, down from 14 percent in 1997. Forty-four percent of the population can be classified as the "interested public" for science and technology issues with the "residual" population also at 44 percent of the total. (See appendix table 8-7.)

The Attentive Public for Science and Technology Policy, by Sex and Level of Education

A direct correlation exists between attentiveness to science and technology policy issues, years of formal education, and the number of science and mathematics courses taken during high school and college. In 1999, only 9 percent of people without high school diplomas were classified as attentive to science and technology policy issues, compared with 23 percent of those with graduate and/or professional degrees. Similarly, 9 percent of those with limited coursework in science and mathematics were attentive to science and technology policy issues, compared with 19 percent of those who had taken nine or more high school and college science or math courses. Men were more likely than women to be attentive to science and technology policy issues. (See figure 8-3 and appendix table 8-8.)

International Comparisons

In the United States, Europe, and Canada, approximately 1 in 10 adults can be classified as attentive to science and technology policy; the proportion is smaller—about 7 percent—in Japan. The percentage classified as the "interested" public (for science and technology policy) is higher in the United States than it is in the other three sociopolitical systems. In 1995, it was 47 percent, compared with 33 percent in Europe (for 1992), 40 percent in Canada (1989), and 12 percent in Japan (1991). For all countries, there is a positive relationship between level of education and level of attentiveness (Miller, Pardo, and Niwa 1997). (See text table 8-2.)

[9]For a general discussion of the concept of issue attentiveness, see Miller, Pardo, and Niwa (1997).

Public Understanding of Science and Technology

Science literacy in the United States (and in other countries) is fairly low. That is, the majority of the general public knows a little, but not a lot, about science and technology. For example, most Americans know that the Earth goes around the Sun and that light travels faster than sound. However, not many can successfully define a molecule, and few have a good understanding of what the Internet is despite the fact that the Information Superhighway has occupied front page headlines throughout the late 1990s—and usage has skyrocketed. (See the section "Use of Computers and Computer Technology in the United States" and chapter 9, "Significance of Information Technologies.") In addition, most Americans have little comprehension of the nature of scientific inquiry.

It is important to have some knowledge of basic scientific facts, concepts, and vocabulary. Those who possess such knowledge have an easier time following news reports and participating in public discourse on various issues pertaining to science and technology. It may be even more important to have an appreciation for the scientific process. Understanding how ideas are investigated and analyzed is a sure sign of scientific literacy. This knowledge is valuable not only in keeping up with important issues and participating in the political process, but also in evaluating and assessing the validity of various other types of information.

In NSF's Survey of Public Attitudes Toward and Understanding of Science and Technology, respondents are asked a series of questions designed to assess their knowledge and understanding of basic science concepts and terms. There are 20 such questions, 13 of which are true/false, 3 are multiple choice, and 4 are open-ended; that is, respondents are asked to define in their own words DNA, a molecule, the Internet, and radiation. In addition, respondents are asked questions designed to test their understanding of the scientific process, including their knowledge of what it means to study something scientifically, how experiments are conducted, and probability.

Understanding Terms and Concepts

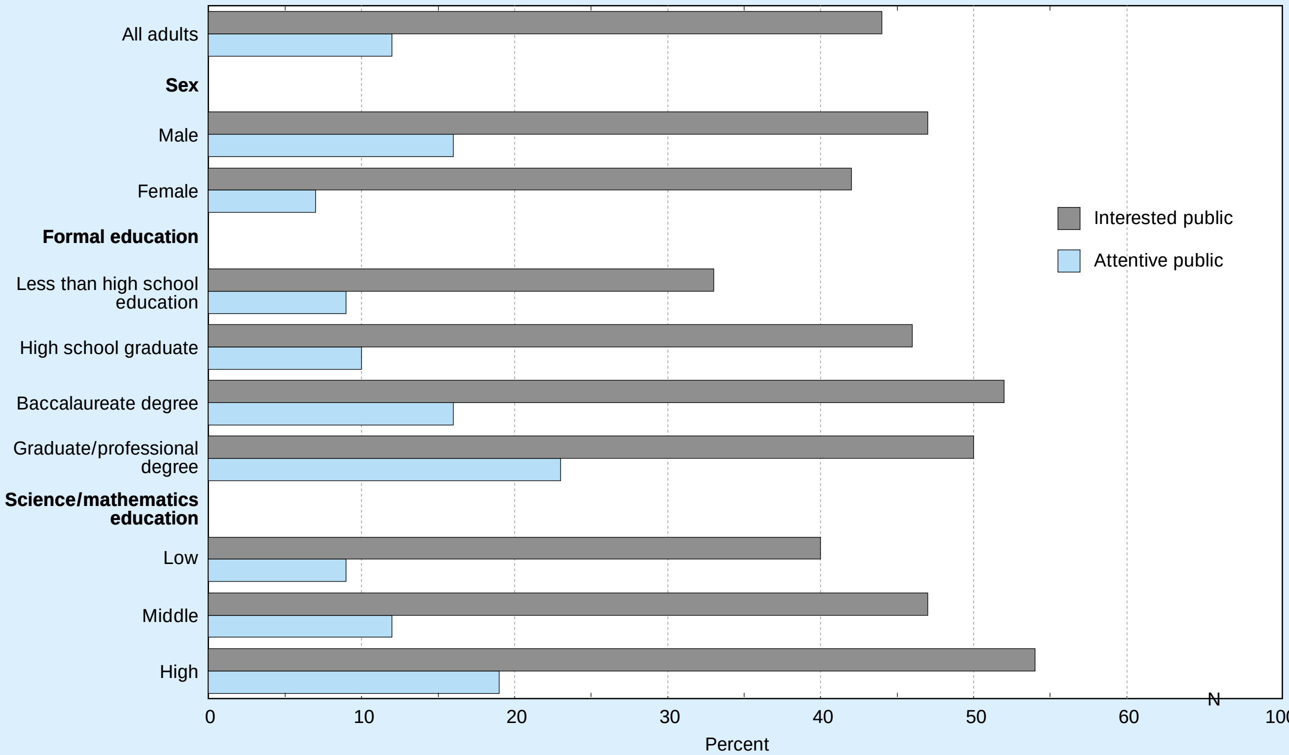
The percentage of correct responses to most of the questions pertaining to respondents' knowledge of basic science concepts and terms was fairly constant in the late 1990s. For example, more than 70 percent of those interviewed knew that:

- Oxygen comes from plants.
- The continents have been moving for millions of years and will continue to move in the future.
- Light travels faster than sound.
- The Earth goes around the Sun (and not vice versa).
- All radioactivity is not man-made. (See appendix table 8-9.)

In contrast, about one-half or fewer of the respondents knew that:

- The earliest humans did not live at the same time as dinosaurs.

Figure 8-3.
Public attentiveness to science and technology: 1999



NOTES: The "attentive" public are people who (1) express a high level of interest in a particular issue, (2) feel well informed about that issue, and (3) read a newspaper on a daily basis, read a weekly or monthly news magazine, or frequently read a magazine highly relevant to the issue. The "interested" public are people who express a high level of interest in a particular issue but don't feel well informed about it. The attentive public for science and technology is a combination of the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Anyone who is not attentive to either of these issues, but who is a member of the interested public for at least one of these issues, is classified as a member of the interested public for science and technology. Survey respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college math/science courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

See appendix table 8-8. *Science & Engineering Indicators – 2000*

Text table 8-2.
Percentage of adults attentive to, or interested in, science and technology

Variable	European Union (1992)		United States (1995)		Japan (1991)		Canada (1989)	
	AP	IP	AP	IP	AP	IP	AP	IP
All adults	10	33	10	47	7	12	11	40
Education								
Less than high school	5	25	4	37	1	8	9	37
High school graduate	9	33	8	48	7	13	11	45
Baccalaureate degree	18	40	21	53	14	15	19	46
Sex								
Male	13	36	12	49	12	15	14	44
Female	7	30	8	45	2	10	7	47
Civic scientific literacy								
Well informed	18	45	29	55	40	26	26	42
Moderately well informed	14	39	14	51	12	21	16	44
Not well informed	7	27	7	45	4	9	8	40
Number of cases	1,226	3,971	195	946	101	177	209	809

AP = attentive public; IP = interested public

SOURCE: J.D. Miller, R. Pardo, and F. Niwa, *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Chicago: Chicago Academy of Sciences,1997). *Science & Engineering Indicators – 2000*

- ◆ It takes the Earth one year to go around the Sun.
- ◆ Electrons are smaller than atoms.
- ◆ Antibiotics do not kill viruses.[10]
- ◆ Lasers do not work by focusing sound waves. (See appendix table 8-9.)

In addition, few respondents (11 percent) were able to define radiation, the Internet (16 percent), a molecule (13 percent), and DNA (29 percent). Although the percentage of correct responses to these questions is considerably lower than that for the short-answer questions, it is noteworthy that the percentage of correct responses to three of these questions increased in the late 1990s:

- ◆ In 1995, only 9 percent of respondents could successfully define a molecule. That percentage rose to 11 percent in 1997 and to 13 percent in 1999.
- ◆ In 1999, 29 percent of the respondents could define DNA, up from 21 percent in 1995 and 22 percent in 1997. Undoubtedly, this growing awareness of DNA is attributable to heavy media coverage of the use of DNA in crime-solving and in advancements in the field of medicine. (See figure 8-4.)
- ◆ The percentage of those able to define the Internet increased from 13 percent in 1997 to 16 percent in 1999.

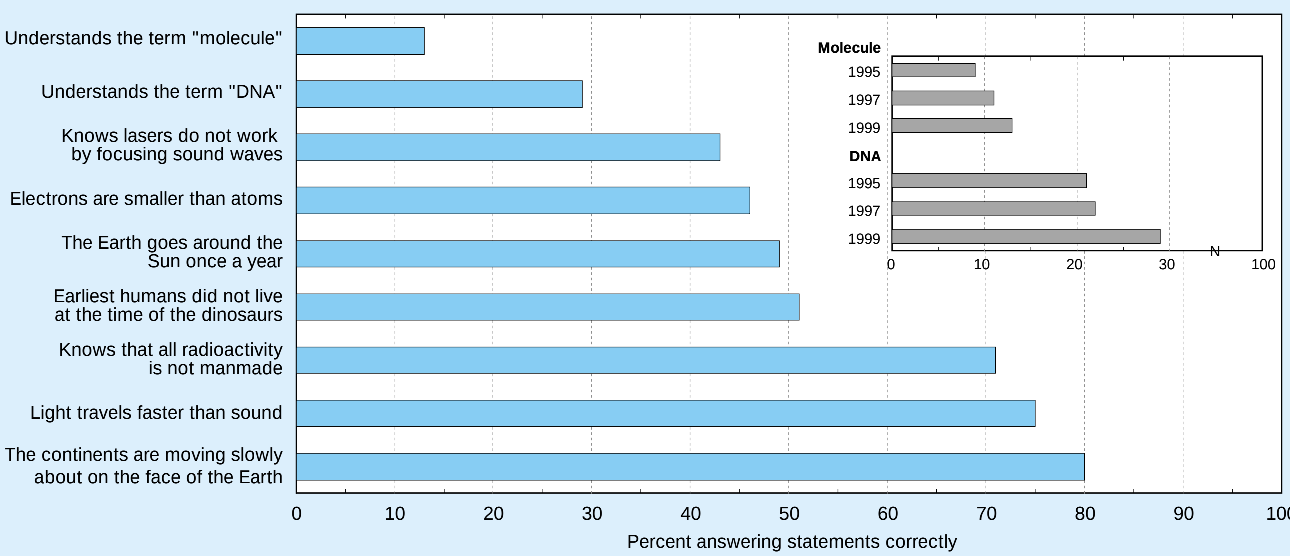
These survey questions have been used to develop an Index of Scientific Construct Understanding, making it possible to track the level of knowledge in the United States over time and to compare that level with the level in other countries.[11] Nine of the survey items are included in this index; they are listed in figure 8-4.[12] The mean score for American adults on the Index of Scientific Construct Understanding was 58. The comparable scores for 1995 and 1997 were 55 for both years. Understanding of basic science concepts and terms is strongly related to both the level of formal education and the number of high school and college science and mathematics courses taken. The mean scores for college graduates and those with graduate or professional degrees were 74 and 80, respectively, compared with 44 for individuals who did

[10]The growing resistance of bacteria to antibiotics has received widespread media coverage in the past few years. In identifying the main cause of the problem—the over-prescribing of antibiotics—it is mentioned that antibiotics are ineffective in killing viruses. Despite the media coverage, more than half of those surveyed answered “true” to the statement “Antibiotics kill viruses as well as bacteria.” Although the percentage of those answering false went up slightly—from 40 percent in 1995 to 45 percent in 1999—the lack of correct responses indicates a lack of communication with the public on this health-related issue.

[11]Although comparable data for other countries have not been updated since the early 1990s, the most recent information available indicates similar scores for the United States, Denmark, the Netherlands, and Great Britain. All have slightly higher scores than France and Germany. For a complete discussion of these data, see chapter 7 in *Science & Engineering Indicators – 1998* (NSB 1998).

[12]The items included in the Index of Scientific Construct Understanding were first identified by confirmatory factor analysis. So that these items could be placed on a common metric applicable to studies in the United States and to studies conducted in other countries, a set of item-response theory (IRT) values was computed for each item, which takes into account the relative difficulty of each item and the number of items used in each study. This technique has been used by the Educational Testing Service and other national testing organizations in tests such as the Test of English as a Foreign Language, the computer-based versions of the Graduate Record Examination, and the National Assessment of Educational Progress. The original IRT score for each respondent is computed with a mean of 0 and a standard deviation of 1, which means that half the respondents would have a negative score. So that more understandable terms could be used, the original IRT score was converted to a 0–100 scale.

Figure 8-4.
Public understanding of scientific terms and concepts: 1999



See appendix table 8-9.

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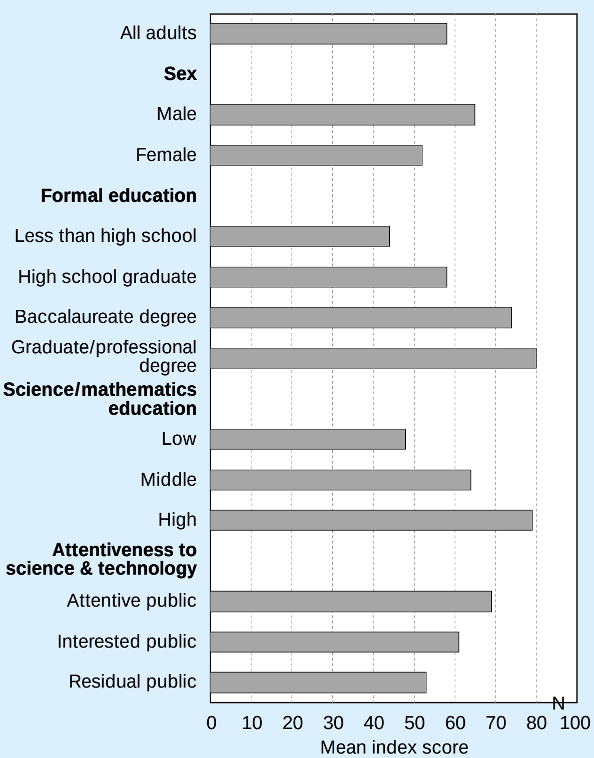
not complete high school. Those who completed nine or more high school and college science or math courses had a mean score of 79, compared with 48 for adults who had taken five or fewer courses. Men scored significantly higher than women, with a mean score of 65 compared with 52 for women. (See figure 8-5 and appendix table 8-10.)

Two of the true/false survey questions (not included in the Index of Scientific Construct Understanding) have relatively low percentages of correct responses:

- ♦ About one-third of the respondents answered “true” to the statement, “The universe began with a huge explosion.”
- ♦ Forty-five percent answered “true” to the statement, “Human beings, as we know them today, developed from earlier species of animals.” (See appendix table 8-9.)

Responses to these two questions may reflect religious beliefs rather than actual knowledge about science. For the last three-quarters of the century, probably the most controversial topic in science teaching has to do with how evolution is taught—or not taught—in U.S. classrooms. In late 1999, states taking opposite sides of the issue received a considerable amount of publicity in the news media. In Kansas and Kentucky, the teaching of evolution was dropped as a required part of the curriculum.[13] (The National Science Board issued a statement in August 1999 on the Kansas action; see NSB 1999.) In contrast, New Mexico’s board of education adopted an “evolution only” policy. For a more comprehensive discussion of curriculum content at the precollege level, see chapter 5, “Elementary and Secondary Education.”

Figure 8-5.
Mean score on Index of Scientific Construct Understanding, by sex, level of education, and attentiveness to science and technology: 1999



See appendix table 8-10. *Science & Engineering Indicators – 2000*

Understanding of Scientific Inquiry

To find out how well the public understands the nature of scientific inquiry, NSF asked survey respondents a series of questions. First, they were asked to explain what it means to study something scientifically.[14] In addition, respondents were asked questions pertaining to the experimental evaluation of a drug[15] and to determine their understanding of probability.[16]

In the 1999 survey, 21 percent of the respondents provided good explanations of what it means to study something scientifically.[17] About one-third answered the experiment questions correctly, including being able to say why it was better to use a control group. More than half (55 percent) of the respondents answered the four probability questions correctly. (See appendix table 8-11.)

The level of understanding of the nature of scientific inquiry is estimated using a combination of each survey participant’s responses to the questions. To be classified as understanding the nature of scientific inquiry, a respondent had to answer all the probability questions correctly *and* either provide a “theory-testing” response to the question about what it means to study something scientifically or provide a correct response to the open-ended question about the ex-

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[13]In an October 1999 poll, sponsored by the *Kansas City Star* and the *Wichita Eagle*, 52 percent of the respondents disagreed with the state board of education’s decision; 57 percent agreed with the statement that “students in science classes in public schools should study and be tested on the idea of evolution, the theory that living creatures have common ancestors and have changed over time.”

[14]The question was, “When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?” If the response is “clear understanding” or “general sense”: “In your own words, could you tell me what it means to study something scientifically?”

[15]The question was, “Now, please think of this situation. Two scientists want to know if a certain drug is effective in treating high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?”

[16]The text of the probability question was, “Now think about this situation. A doctor tells a couple that their ‘genetic makeup’ means that they’ve got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple’s children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?”

[17]A correct understanding of scientific study includes responses describing scientific study as theory testing, experimentation, or rigorous, systematic comparison.

periment, i.e., explain why it was better to test a drug using a control group. In 1999, 26 percent of the survey respondents gave responses that met these criteria. (See figure 8-6 and appendix table 8-11.) In 1995 and 1997, the comparable percentages were 21 percent and 27 percent, respectively.

Public Attitudes Toward Science and Technology

In general, Americans express highly favorable attitudes toward science and technology. In the 1999 NSF public attitudes survey, overwhelming majorities agreed—and few disagreed—with the following statements:

- Science and technology are making our lives healthier, easier, and more comfortable (90 percent agreed and 9 percent disagreed).
- Most scientists want to work on things that will make life better for the average person (83 percent agreed and 15 percent disagreed).
- With the application of science and technology, work will become more interesting (73 percent agreed and 23 percent disagreed).
- Because of science and technology, there will be more opportunities for the next generation (84 percent agreed and 14 percent disagreed). (See appendix table 8-12.)

In a 1996 survey,

- Nearly half the respondents said that the terminology that best describes their reaction to science and technology was "satisfaction or hope"; 36 percent chose "excitement or wonder"; and only 6 percent answered "fear or alarm."
- More than half the respondents said that new developments in science and technology will have a positive impact on the overall standard of living in the United States; one-fifth thought the impact would be negative.
- Approximately four out of five respondents agreed that encouraging the brightest young people to go into scientific careers should be a top national priority (Roper 1996).

Despite these indicators, a sizeable portion—although not a majority—of the public has some reservations concerning science and (especially) technology. See sidebar, "Attitudes of Scientists, Legislators, and the Public Toward Science and Technology." For example, in the 1999 NSF survey, half of those queried agreed with the statement: "We depend too much on science and not enough on faith" (45 percent disagreed). And, about 40 percent agreed that "science makes our way of life change too fast" (57 percent disagreed). (See appendix table 8-12.)

Overall, however, there seems to have been a small, upward trend in positive attitudes toward science and technology. In general, data from the NSF survey show increasing percentages of Americans

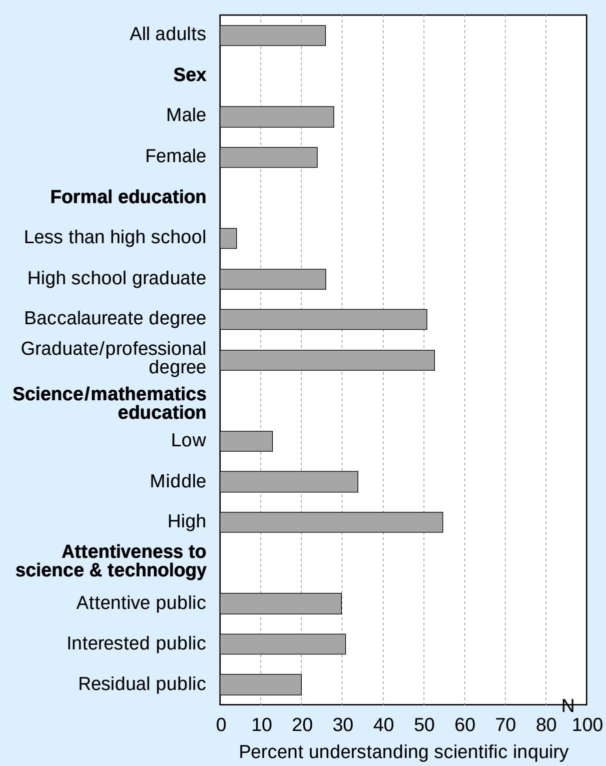
- *agreeing* that "science and technology are making our lives healthier, easier, and more comfortable" and
- *disagreeing* that "we depend too much on science and not enough on faith." (See appendix table 8-13.)

In addition, the survey results indicate that an increasing number of people believe that the benefits of scientific research outweigh any harmful results. (See the section "Perceptions of Scientific Research.")

The concern that does exist appears to be related to the impact of technology on society. For example, NSF survey respondents were fairly evenly split about whether "computers and factory automation will create more jobs than they will eliminate." (See appendix table 8-14.) And, a sizeable minority—46 percent—agreed with the statement that "people would do better by living a simpler life without so much technology." (See appendix table 8-15.) Also, about 3 out of every 10 people surveyed agreed that "technological discoveries will eventually destroy the Earth" and that "technological development creates an artificial and inhumane way of living." (See appendix tables 8-16 and 8-17.)

In a 1999 survey, more than half the respondents (55 percent) agreed with the statement, "Our growing reliance on technology is generally good because it makes life more convenient and easier." However, 39 percent of the respondents

Figure 8-6.
Public understanding of the nature of scientific inquiry: 1999



See appendix table 8-11. *Science & Engineering Indicators – 2000*